CHAPTER 2

SUBGRADE

2-1. Preliminary investigations. The subgrade provides a foundation for supporting the pavement and base course. As a result, much of the required pavement thickness and the performance obtained from the pavement during its design life will depend on the strength and uniformity of the subgrade. It is desirable a thorough investigation of the subgrade be made so that the design and construction will insure uniformity of support for the pavement slab and realization of the maximum strength potential for the particular subgrade soil type.

a. Site investigations. Insofar as time will allow, investigations of subgrade conditions at the site of proposed construction should be performed to determine the engineering characteristics of the subgrade soils, and the extent of any peculiarities of the proposed site which might affect pavement behavior. Such investigations should determine the general suitability of the subgrade soils based on: (a) classification of the soil, (b) moisture-density relation, (c) degree to which the soil can be compacted, (d) expansion characteristics, (e) susceptibility to pumping, and (f) susceptibility to detrimental frost action. In order to give consideration to factors that may affect the performance of the pavement, a review of the service history of existing pavements on similar subgrades in the locality of the proposed site should be made. The engineer is cautioned that such factors as ground water, surface infiltration, soil capillarity, topography, rainfall, and drainage conditions also may affect the future support rendered by the subgrade.

b. Soil conditions. A general picture of the subgrade conditions to assist in determining the representative soils should be developed. Field reconnaissance should be made to study landforms and soil conditions in ditches and cuts. Full use also should be made of existing agricultural soil maps and geological maps in ascertaining subgrade conditions. Advice from contractors actively involved in the subject area should be solicited.

(1) Additional subsurface explorations should be made in those areas where the initial investigation indicates unusual or potentially troublesome subgrade conditions. Subsurface explorations should be carried to a minimum depth of 3 feet below the design grade.

(2) In-place moisture content should be determined to ascertain the presence of soft layers in the subsoil. Both natural and subsurface drainage of the subgrade soils must also be considered.

c. Borrow areas. Material in borrow areas should be visually inspected to insure that objectionable materials are not present.

2-2. Soil classification and tests. All soils should be classified in accordance with the Unified Soil Classification System as given in MIL-STD-619.

2-3. Compaction. Compaction improves the stability of the subgrade soils and provides a more uniform foundation for the pavement slab or base course. The CE-55 soil compaction test is used to determine the compaction characteristics of the subgrade soils and is given in MIL-STD-621. This is abbreviated as a percent of maximum density. Density measurements could also be made by the following procedure:

- Materials representing the soils at the project site are taken to a laboratory where moisture-density relationships are ascertained (ASTM D 1557). From these relationships, the material's maximum density, occurring at optimal water content, is determined. These relationships establish the bases to which field measurements are compared.

- Field in-place density tests are made at critical locations at the construction site. These tests can be the sand-cone test (ASTM D 1556), the balloon test (ASTM D 2167), or the nuclear test (ASTM D 2922). In-place density test values are then divided by the maximum obtainable and multiplied by 100 to obtain the percent maximum density.

a. Cut sections. With the exception of those areas in which the soil exhibits expansive characteristics or those areas composed of cohesionless sand or sandy gravel subgrades, the entire subgrade area should be scarified, moistened, if necessary, to approximately optimum moisture content, and compacted to a minimum of 90 percent of maximum density. If the densities of the natural subgrade materials are equal to or greater than 90 percent of the above-mentioned maximum value, no rolling is necessary other than that required to provide a smooth surface. In the case of cohesionless sands or sandy gravels, these materials should be compacted to a minimum of 95 percent of maximum density. For all subgrade soil types, it is required that the subgrade under the pavement slab or base course be compacted to a depth of 6 inches.

b. Fill sections. With the exception of fills composed of soils exhibiting expansive characteristics or those composed of cohesionless sands or sandy gravels, all fills should be compacted to a minimum of 90 percent of maximum density. In the case of fills composed of cohesionless sands or sandy gravels, the entire depth of the fill should be compacted to a minimum of 95 percent of maximum density.

2-4. Treatment of unsuitable materials. Materials unsuitable for pavement subgrades are:

- organic soils - top soil, loam, peat, bog, etc.

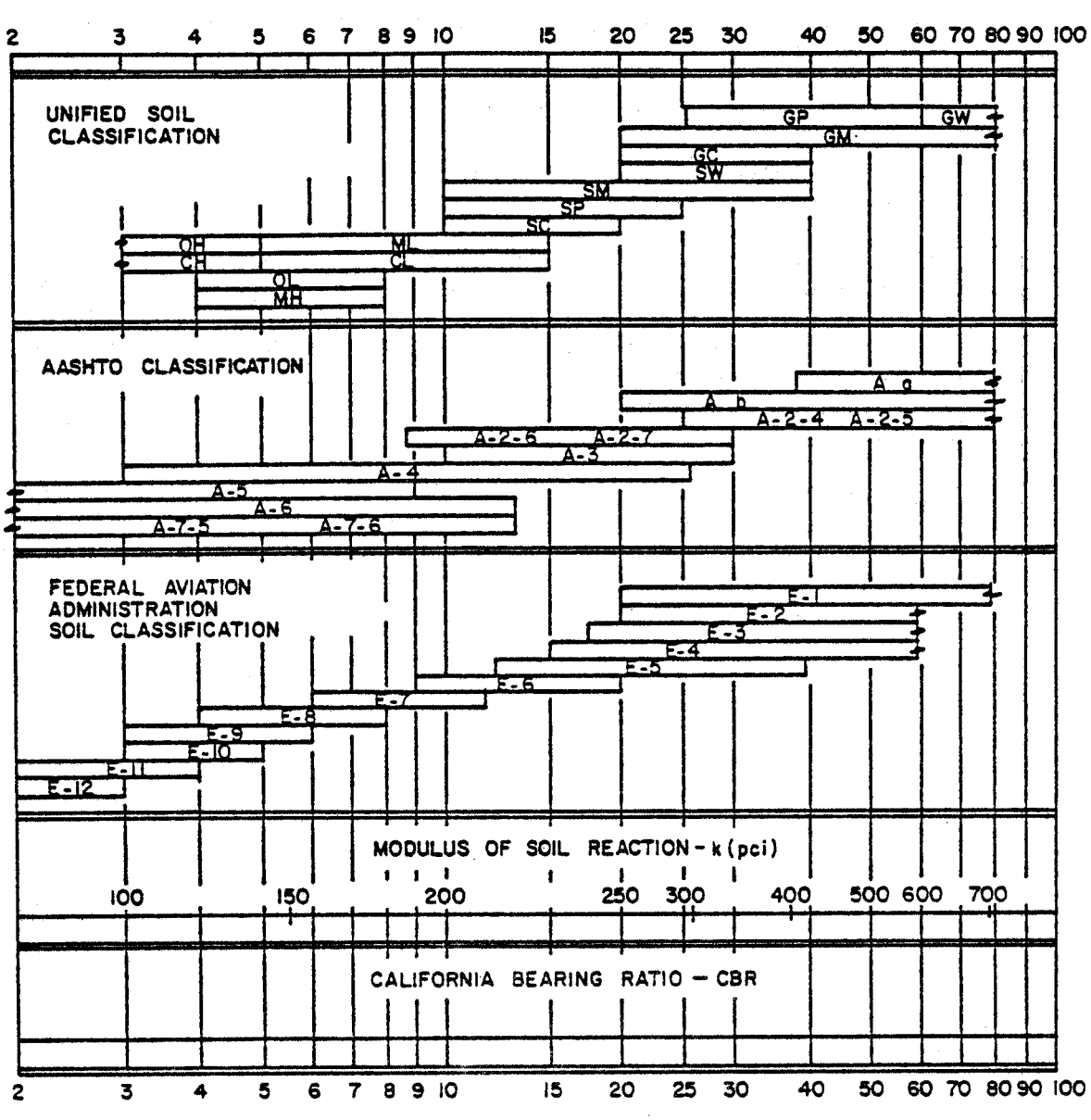
- excessively shrinking or expanding soils upon drying or moisture absorption.

- excessively wet soils such as quicksand or mud.

- soils which show a marked decrease in stability when scarified, worked, or rolled.

Such soils should be removed and replaced, or covered with soils which are suitable. The depth to which such adverse soils should be removed or covered depends on the soil type, drainage conditions, and depth of freezing temperature penetration and should be determined by the engineer on the basis of judgment and previous experience, with due consideration of the traffic to be served and the time element involved.

2-5. Determination of modulus of subgrade reaction. For the design of rigid pavements, the modulus of subgrade reaction, k, is used for design purposes. It usually is determined by the field plate-bearing test. However, when time will not allow for this testing, the subgrade modulus value can be determined from figure 2-1.



PCA Soil Primer (EB007.068), With Permission of the Portland Cement Association, Skokie, IL.

FIGURE 2-1. APPROXIMATE INTERRELATIONSHIPS OF SOIL CLASSIFICATION AND BEARING VALUES